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THE

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THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

Edited by

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THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle.

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NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address:—Research, Talawakelle; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

EDITORIAL.

TEA RESEARCH INSTITUTE SUB-CONFERENCE

The first Sub-Conference of the Tea Research Institute was held at St. Coombs on Thursday, 21st March. In contrast to the major conferences, attendance at this meeting was limited to delegates nominated by the Planters' Association of Ceylon, Ceylon Estates Proprietary Association, Low-Country Products' Association, District Planters' Associations and the Board of the Institute. Of fifty-five delegates entitled to attend, thirty-seven were present.

One of the primary objects of these smaller meetings is to provide an opportunity for the Associations represented to bring forward for discussion any matters which may be deemed to be of particular interest to their districts. It is possible, however, this was not fully appreciated. Prior to the Conference, circulars were issued to all Associations concerned and to individual delegates, inviting suggestions as to the subjects which should be placed on the Agenda. Very few replies or suggestions were, however, received in response to this circular. The following programme was eventually arranged :—

1. Discussion on certain aspects of manufacture.
    (a) Costs in relation to war conditions.
        (i) Fuels.
        (ii) Withering materials.
        (iii) Packing materials.
    (b) Fermentation periods.
2. Discussion on manuring and cultivation with special reference to war conditions.
3. Discussion on pests and diseases.
    (a) Shot-hole borer and other pests.
    (b) Diseases.
4. Discussion on tea selection and propagation.

Good discussions were held on the above subjects and a full report of these will be found in the present issue.

In regard to future similar conferences it would seem desirable, however, that, if possible, the conference programme should be discussed by District Planters' Associations prior to the meeting. Delegates would then be in a position to put forward the considered views of their districts on the various points raised and the information thus obtained would be of the greatest use to the research officers.

PACKING MATERIALS

On the outbreak of war considerable uncertainty prevailed as to future supplies of aluminium foil for tea chest linings and this is still the case. Under the conditions of the Government contract teas have to be packed in chests lined with aluminium or lead foil or such other materials as may be specifically approved by the Ministry of Food in London. As is well known the Institute had already carried out numerous tests on various alternative linings such as Kraft Paper, Pliofilm, Cellophane, etc., and was satisfied that some of these materials were entirely suitable for use as linings. In regard to Kraft Paper numerous shipments were also made by estates with, so far as is known to the Institute, entirely satisfactory technical results. Opposition was, however, met with from buyers owing to the fact that these materials in contrast to the conventional metallic linings had little or no second-hand value. It was felt, however, in view of war conditions in which supplies of aluminium and lead must necessarily be diverted for military purposes, such an objection would no longer be sustained. It was considered, therefore, in the interests of the Tea Industry that representations should be made to the Ministry of Food urging that the use of alternative tested materials such as Kraft Paper should be made permissible. In the event of any deterioration in the position as regards supplies of metal foils it would then have been possible to change over to such alternative materials without undue delay or inconvenience.

It is to be regretted, however, that these representations have so far been unsuccessful. While permission for the use of Kraft Paper has been given in certain cases for special reasons, the Minister for Food, London, has intimated that he is not at present prepared to issue any general permit for the use of this material.

FERTILISER SUPPLIES

The Institute has since the war maintained close touch with the firms supplying fertilisers and two meetings have been held in Colombo in which the whole question of the utilisation of available stocks in a manner fair to all concerned has been reviewed. Further such meetings will be held as required. The chief concern is of

course the question of inorganic nitrogen supplies. At the beginning of the war there were stocks of ammonium sulphate in Ceylon equivalent to about six months' normal requirements. In view of the embargo on the export of nitrogen from the United Kingdom which was then imposed, it was obviously desirable to conserve such stocks in order to equalise manuring costs over as long a period as possible and an agreed scheme of rationing was arranged. In practice, the nitrogen embargo has been relaxed but, owing to the heavy demand for ammonium sulphate which normally occurs in the United Kingdom during the spring months, supplies have not as yet been easily available. Certain shipments have been received, however, both from the United Kingdom and other sources of supply, and it is satisfactory to note that for the period 1st September, 1939 to 31st March, 1940 these have amounted to approximately 13,470 tons, a figure higher than was originally anticipated. It is possible that in the near future the position may ease further, but difficulties in regard to freight must in any case make deliveries uncertain and irregular. It must not be anticipated therefore that rationing will be dispensed with, while future supplies are likely to be more expensive.

ROLAND V. NORRIS.

TEA RESEARCH INSTITUTE SUB-CONFERENCE

HELD AT ST. COOMBS ON THURSDAY, 21st MARCH, 1940

The Director in opening the Conference extended a warm welcome to the delegates and thanked them for coming to St. Coombs to take part in a discussion, which, he hoped, would be full and detailed, of the various items on the Agenda.

The Director said it would be well for him to explain the origin of, and the reason for, the smaller conferences. It would be remembered that at the Conference held in 1939, several speakers had urged the desirability of setting up machinery to maintain closer contact between the Institute and districts in the intervals between the large Conferences held every two years. The point had further been made that, if smaller meetings were held during these intervals, it would be possible to discuss in more detail than was feasible when some three hundred visitors were present, problems of general interest and, in particular, problems concerning which there might be some difference of opinion.

These suggestions had been considered by the Board of the Institute and felt to have weight. Proposals had accordingly been made to, and approved by, the Planters' Association of Ceylon, the Ceylon Estates Proprietary Association and the Low-Country Products' Association that a Committee should be set up consisting of two members nominated by each of these Associations, two representatives of each District Planters' Association and ten members nominated by the Board to represent Proprietors, Visiting Agents and unorganised interests and that this Committee should have occasional meetings at St. Coombs. Delegates had duly been appointed on the above basis and the meeting to be held that day would inaugurate the scheme.

Dr. Norris went on to say that he had previously indicated that one of the chief objects sought was to afford to District Associations and the other groups represented, an opportunity to bring to the notice of the Institute for discussion and elucidation any special problems which might be considered to be of particular importance or interest to their members. Accordingly when it was decided to hold the Conference, a circular had been issued to all the Associations concerned, and to the fifty-two individual delegates, inviting them to send in suggestions for subjects to be included in the Agenda.

He had been somewhat disappointed at the response to this circular as very few replies had been received and only in some six or seven cases had proposals been put forward. He thought, however, that was probably due to the fact that the reasons for the Conference had not been fully realised and he did not wish to suggest that any lack of interest was indicated in the objects which the meeting was intended to serve. He hoped they would agree that an Agenda had been drawn up containing items of wide general interest, particularly under present conditions, and some of which came sufficiently into the controversial field to add an additional flavour to the discussions.

Dr. Norris said it had been usual for him at the major Conferences to open the proceedings with a general review of the work of the Institute. He did not propose to do so on that occasion as the Annual Report for 1939 would shortly be issued which would provide this information and he wished the whole of the time to be available for *discussion* of the items on the Agenda.

No formal papers would be given by members of the staff and, in fact, most of the discussions were to be initiated by delegates to the Conference. The papers already issued to delegates had indicated the general direction in which it seemed these discussions might profitably develop. He wished to make it clear, however, that this had been done merely to assist members in formulating their views and not with the intention of precluding discussion of other aspects of the various issues raised. It was his hope that the discussions would be as informal as possible and that the freest possible exchange of views might take place; this would be of the greatest value to the staff.

Dr Norris pointed out that conditions varied greatly in the different tea districts and the problems and difficulties which arose were by no means common to all. In organising the work of the Institute it was naturally desired to strike a reasonable balance between these different requirements, and in the advisory work it was necessary to adapt general recommendations to the special circumstances which prevailed in different areas. These two objects could be achieved only if the closest contact was maintained with all districts and if the Institute were kept constantly advised as to any difficulty which might arise in the practical application of such recommendations. He asked all delegates therefore to take advantage of the Sub-Conference and to assist the Institute by putting forward as freely as time would allow the point of view of their districts on the various subjects to be discussed.

DISCUSSION ON CERTAIN ASPECTS OF MANUFACTURE

A.—COST IN RELATION TO WAR CONDITIONS

DR. NORRIS said there were one or two questions under this head which had either been raised by delegates or concerning which the Institute would be glad to obtain further information.

(I). FUELS

In regard to fuels the Dimbula Planters' Association wished to bring up the question of (a) lack of fuel up-country and (b) the relative advantages of different fuels in regard to quality. Dr. Norris asked Mr. Morford to speak on these points.

MR. MORFORD said that owing to illness, Mr. Newton, who had first raised the questions, was unable to be present at the Conference. He had, however, discussed matters concerning timber supplies with Mr. Newton and they thought it would be a good plan if the Tea Research Institute could get into touch with the Forest Department with regard to the general question of fuel supplies which were causing anxiety up-country. Mr. Morford referred to a publication in *The Tea Quarterly* some time ago which gave figures for the yields of fuel clearings up-country. He was under the impression that these figures, 400 yards per acre, were for 6 years' growth, and requested the Tea Research Institute to obtain further details about this important matter.

MR. MORFORD went on to refer to difficulties in the working of Government fuel blocks and thought that there was opportunity for closer co-operation between the Forest Department and the Tea Research Institute. Continuing, he said that in recent years he had gained the impression that when firing with firewood, mainly Albizzia, possibly mixed with some gum, remarks had appeared in the brokers' reports relating to "maltiness." He found that when he used other fuels the remarks about maltiness did not appear in the reports, and he wondered whether there was some quality about firewood as opposed to other fuels, which had not so far been fully appreciated.

MR. LAMB in reply said that the only possible explanation of these differences was the control of the furnace. Oil fuel, for instance, was capable of generating much higher temperatures than other fuels used in tea driers, and it had been pointed out in

The Tea Quarterly, 1936, that with oil it was essential to have a properly constructed furnace which would not only conserve the heat but protect the furnace itself from damage. When burning coal, stoking, again, was of the utmost importance, and the fire bed should never be more than four inches thick. Otherwise very erratic results might be obtained. When burning firewood, stoking was of much less importance and the control depended largely on the amount of draft allowed in the furnace. It was still not generally realised how great the differences in the weights of various fuels might be. The stove might be packed full of Albizzia and yet the weight of combustible matter, and therefore potential heat, was very small. On the other hand, a small quantity of old red gum contained a much larger weight of combustible matter and if allowed to burn fiercely with excessive draft would generate quite high temperatures. There was no direct connection between flue gases and the air fed to the drying chamber, and therefore the observed differences in the quality of the fired teas must be due to these differences in the stoking and draft control which might be very considerable.

Mr. Lamb again drew attention to articles which appeared in *The Tea Quarterly* during 1936 and also to an article by Mr. H. C. King (*Tea Quarterly*, 1935) late of the Ceylon Forestry Department, with regard to the supply of firewood for tea estates. He stressed the fact that firewood was a very much cheaper fuel than imported fuels and that its supply and use was therefore of the utmost importance. The fact that firewood was indigenous and easy to deal with sometimes led to its virtues being overlooked. Its advantage might not be realised until its cost had gone up.

Mr. Whitehead said he would like to support Mr. Lamb's remarks and drew attention to the possibility of liquid condensate from the furnace causing taints. A brown strongly coloured liquid was sometimes observed oozing from the tea drier furnace and if air used for drying were drawn over this it might become tainted and impart this taint to the tea. He pointed out that one of the easiest ways of obviating condensation was to cut the firewood very small — as small as would be used in the kitchen stove — such small fuel would burn fairly quickly and be very sensitive to draft control. He thought that Mr. Morford's observation could be fully explained on these lines.

Mr. Coombe said that Mr. Morford had mentioned 400 yards per acre as being the yield from a fuel clearing. He had done a good deal in this connection for the last twenty-five years and was wondering at the difference between Mr. Morford's figures and those from his own experience. He had found that planting at 8×4, anything up to 500 yards per acre could be obtained from gums and that such

fuel, together with Albizzia and Grevillea, was most efficient. The advantage with gums was that they could be recut after seven or eight years and he knew of an estate close to his own where two or three blocks were being cut for the fourth time within thirty years.

MR. LAMB commented that so far as he could remember Mr. King had recommended a planting distance of 6 feet × 6 feet.

MR. RETTIE remarked that much depended on the type of land and referred to plots on patna soil which yielded under 100 yards per acre. He said that he did not think it was possible to lay down any fixed standards.

MR. MORFORD then said he wished to emphasise the lack of co-operation between Government and themselves over the matter of fuel blocks.

MR. KEILLER said Mr. Whitehead had suggested that "maltiness" might be due to a taint. He understood that maltiness was regarded with favour by the Tea Trade and thought, to obtain this desirable character, there might be some advantage in firing with damp fuel which would burn slowly.

DR. NORRIS said it was necessary to clarify what was meant by "maltiness." As usually used by brokers the comment was a favourable one, but was generally associated with rather high firing.

MR. GOURLAY suggested enquiries should be made as to whether the Forest Department was still convinced that gums gave the best returns.

MR. COOMBE reiterated that the advantage with gums was they could be coppiced whereas Grevilleas and many other fuels could not be. In his experience coppicing was most successful with gums.

DR. NORRIS said that he would get in touch with the Forest Department and endeavour to obtain some of the information called for.

MR. SCOTT then gave an account of his experience with a heater on the same principle as the Java heater which had been designed and erected on his own estate by the Shell Company of Ceylon. It had given him very little trouble and the teas fired in a drier attached to this heater were in his opinion very good. The cost of firing, up to the recent increase in the price of liquid fuel, had been 0.6 cent per pound for firing only which he thought was a very reasonable rate.

DR. NORRIS remarked that Mr. Forbes and himself had seen something of this type of heater in Java. Mr. Scott had said that the machine could only be used with liquid fuel. In Java they were

told that it could be adapted for use with producer gas derived from charcoal. For this purpose modification of the burners was, however, required.

Mr. Lamb referred to a fundamental difficulty with regard to the cost of firing by the Java or any other oil-fired heater. The heater was admittedly most efficient, reaching almost 100 per cent thermal efficiency, but the cost of heating must be related to the cost of heat units in the fuel. Referring to *The Tea Quarterly*, 1936, Mr. Lamb quoted figures from a table which he had published showing the cost of 10,000 British Thermal Units in various fuels delivered at St. Coombs factory. The cost of 10,000 British Thermal Units from red gum was 0.45 cent and from oil 1.74 cents. Assuming 100 per cent efficiency with a Java heater at the stove and only 50 per cent efficiency in a furnace burning red gum, the relative costs were 1.74 cents as against 0.9. This difficulty could not be overcome until the cost of imported fuels was reduced in comparison to firewood.

Mr. Farquharson said that Insurance Companies wanted the furnace put further and further away from the drier and asked Mr Whitehead or Mr. Lamb if they could say whether this would affect condensation and the cost of firing.

Mr. Lamb said that the heat lost from the longer duct would not be sufficient to affect materially the cost of firing. With regard to condensation, it was not generally realised that all fuels formed large quantities of water as a product of combustion and that difficulties with condensation must be laid at the door of the furnace designer rather than the fuel supplier.

(II). WITHERING MATERIALS

Dr. Norris said that he had put this down on the Agenda of the Conference because of the recent very heavy increase in the cost of jute hessian. Since then, however, he understood that there had been a very substantial drop in the price owing to Government having come to certain arrangements with the suppliers. Even so, the cost of jute hessian was still very high and other types of withering materials might have to be considered.

With regard to withering on pine boards, he had received a letter through the Chairman of the Rangala and Urugala District Planters' Association from Mr. A. H. Kerr of Ferndale Estate, Rangala. This read as follows:—

> "My own personal experience is that withering of leaf on boarding is more even, week in and week out. After once put in costs are nil; mine were put in 1923, and so

far I have not spent a cent on them. Pine is too soft. *Rât sappu* is about as good a wood as any, and fairly clean. Boards have to be put in crossways, not lengthways, they are then much stronger, and the leaf comes off cleaner."

Dr. Norris said that he would be grateful if any other members who had used boards would tell the Conference of their experience.

Mr. Rettie said that he had used pine boards for a good many years and the drawback was that, firstly, they became very sodden in the rains and, secondly, that on removing the leaf a great deal of damage was done to this. A third point was that the leaf was invariably blackened. He had given boards up as unsatisfactory. He had tried asbestos sheets as well and had more or less the same experience. With wire there was again the difficulty of removing the leaf and he did not think any other material could be found as good as hessian.

Mr. Morford said that he had used wire mesh tats for some time and found them extremely satisfactory. He had had no difficulty whatever with withers which were very even. He found that the solution to the problem of getting the leaf off was to instal the tats with a slight slope and to leave them slack, so that they could be tapped underneath and the leaves in that way dislodged. Wire mesh gave a very even wither throughout the year and they had proved satisfactory over a period of seven or eight years. There was, however, a tendency for the leaf to hang down.

In reply to Mr. Rettie, Mr. Morford said he had no trouble in regard to spreading.

Mr. Ross enquired whether anyone had experience of locally woven material.

Dr. Norris said that locally made cotton cloth had been tried out for some time but had not been found very satisfactory. In the wet weather the cloth shrank under the influence of the wet leaf and tended to split. On drying during withering it sagged and gave trouble with the withers.

Mr. Lamb said that a large number of different withering materials had been tried out over a considerable period and the leaf withered on them had been manufactured and sent to teams of tasters in Colombo and in London. On averaging out the results of these tests there was little or no difference between the various materials except for the cotton cloth which gave slightly inferior results owing to the difficulties referred to by Dr. Norris.

In reply to Mr. Farquharson who asked whether there was any trouble with rust on wire mesh, Mr. Morford replied that there was not.

Mr. Scott said in his experience wither material with an open weave had given better results than ordinary hessian but did not wear at all well.

Mr. D. T. Angus said in regard to the question of wire mesh nobody had mentioned cost. When he erected wire mesh tats in 1920 it cost him more than twice as much as jute hessian and he thought that was a most important point, as it did not seem to last any better than jute hessian.

Mr. H. F. Norris then read a letter he had received in relation to the possible use of New Zealand flax which read as follows:—

> "I see they may wish to talk about withering tat materials. Herewith I send some New Zealand flax. If people could grow this and aloes and a local firm spin them into sheets like hessian we would be self-supporting in tat material.
>
> Aloes as you know grow anywhere and the flax will, judging by what I have here, grow up-country, under jungle that is not too dense, probably along river edges, (Very useful for holding up soil), Bo pats, Nuwara Eliya, etc.
>
> I have some tats made out of Irish flax so why not locally grown New Zealand flax?"

[*Note*.—Arrangements are being made for plants of this material to be tried out in two or three areas.]

(III). PACKING MATERIALS

The Director said that under the terms of the Government tea contract all teas shipped to the Ministry of Food had to be packed in chests lined with aluminium or lead foil or any other material specifically approved by the Ministry. Aluminium and lead were both materials, the supply of which was likely to depend on war requirements. He understood that there was already considerable uncertainty in regard to future supplies of aluminium as this metal was controlled by Government. It seemed therefore that the utilisation of alternative materials should be considered. Delegates were aware that the Institute had already carried out extensive tests on certain alternatives such as Kraft Paper, Pliofilm, Cellophane, etc. Very satisfactory results had been obtained with some of these which had been confirmed by commercial invoices shipped by many estates.

The Institute was aware that many buyers objected to these alternatives on the ground that they had little or no second-hand value compared with the conventional metallic foils. It appeared unreasonable that an objection of this type should be maintained in the circumstances created by the war, and it had seemed to him desirable that permission to use tested materials such as Kraft Paper should be obtained before the position possibly became acute. He had accordingly approached the Minister for Food in London to obtain such permission.

With regard to chests, a considerable number of locally made chests, particularly Albizzia chests, were now being put on the market. Many of these were of excellent quality but it was essential that most careful inspection should be made of such chests to ascertain that they were free from borer attack. Some years previously trouble had arisen from the use of chests attacked in this way, particularly in regard to the Australian market, and unless precautions were taken such trouble might recur causing much inconvenience to shippers and bringing into disrepute a promising local industry.

A number of other timbers, supplied by the Forest Department, had also been examined by the Institute and here again the same risk had to be guarded against as some species were heavily attacked by borers. Dr. Norris, therefore, stressed that most careful inspection should be carried out.

In reply to Mr. Coombe who asked whether the Ministry of Food were aware of the objection raised by certain buyers in regard to Kraft Paper the Director said he had based his case on the facts that this material had been shewn to be technically satisfactory and that by its use aluminium stocks could be conserved. He thought the present was an excellent opportunity for a more extensive trial of Kraft Paper and other alternative types of linings. He had no wish to prevent the use of aluminium or lead while these were freely available at a reasonable cost but merely wanted to make the use of certain alternatives *permissible* so that a change-over could be made without difficulty or delay should an emergency arise.

Mr. Keiller strongly supported the Director's view that all possible precautions should be taken to avoid the use of chests showing any evidence of borer attack and confirmed the Director's account of the trouble that had arisen on a previous occasion from this cause. He asked if the Institute could not inspect supplies and stamp them as approved.

The Director said this would be quite impossible. There was considerable evidence to shew that the liability to borer attack was

greatly reduced by rapid drying of the timber used in making the chests. The only real safeguard, however, was rigorous inspection of chests before these were taken over.

Mr. Lamb pointed out that Momi chests from Japan had also been found to suffer from borer attack but careful inspection in importers' stores had prevented trouble arising. Similar precautions should be taken in regard to locally made chests.

[*Note.*—Information has later been received from the Minister for Food in London that he is not at present prepared to give general permission for the use of Kraft Paper as an alternative packing material to lead or aluminium foil.]

B.—FACTORS GOVERNING FERMENTATION PERIODS

Mr. Whitehead opened the discussion by pointing out that tea manufacture was, in the initial stages, essentially a batch process commencing with one large batch, *i.e.*, the leaf in the field ready for plucking during the day.

This first batch might be, say, 7,500 lbs. of green leaf, which would be broken down into three batches by the pluckers sending to the factory three deliveries of green leaf during the course of the day. After withering, the weight of the day's leaf would be approximately 4,000 lbs. and this weight of withered leaf would then be further sub-divided into a larger number of batches for rolling, say, eight batches of 500 lbs. or ten batches of 400 lbs.

If rolling were done five times, each of the above ten batches would be again sub-divided into six batches, *i.e.*, five dhools and a big bulk, or sixty batches of fermented leaf in all.

To tabulate:—

1 batch, the day's leaf in the field, say,	7,500	lbs.
3 batches, morning, noon and evening leaf resulting in total withered leaf	4,000	lbs.
10 batches, withered leaf for rolling	400	lbs. each
60 batches, dhools and bulk, for fermentation.		

For each and every one of these sixty batches of fermented leaf there would be a different firing time if fermentation were to be correct, and this discussion had to deal with the various factors governing fermentation.

(1). *Weight of Rolled Batch and Size of Drier.*—Assuming that the drier to be used could take fermented leaf at the rate of eight pounds per minute and the weight of the rolling batch was 400 pounds, in such a case this weight of fermented leaf could be fed into the drier in 50 minutes.

If, therefore, judgment decided that the first leaf of this batch should have 2 hours 40 minutes' fermentation, then the last leaf of the same batch could receive 3 hours 30 minutes' fermentation. But if the weight of the rolling batch had been, say, 1,200 lb., and the same period, *i.e.*, 2 hours 40 minutes, was judged to be correct before the first leaf was fired, it would be necessary to give the last leaf of this batch as much as 5 hours 10 minutes' fermentation. Thus judgment decided in both cases when the *first* leaf to be fired was fermented correctly but the weight of the batch and the size of the drier decided the minimum possible fermentation periods for the balance of the batch.

Mr. Gibbon asked why in the latter case two driers should not have been used.

Mr. Whitehead pointed out that if two driers of similar capacity had been used, the total drying time for the day would be only 4 hours 10 minutes and this would be very uneconomical even if the rolling capacity was big enough to produce 4,000 lb. rolled leaf in so short a time, which was very unlikely.

Mr. Perera asked what particular drier was under discussion to which Mr. Whitehead replied that the data referred to any modern four-foot drier.

(2). *Length of Rolling Programme.*—If a four-roll programme of, say, four 30-minute rolls were compared with a six-roll programme also having 30-minute rolls, the earliest possible time the sixth dhool or big bulk in the latter programme could be fired would be 4 hours against a minimum time of 2 hours 40 minutes in the former. If therefore 4 hours' fermentation was found to be too much for the bulk a rolling programme having fewer rolls than 6 or one having shorter rolling periods must be adopted.

Mr. Rettie remarked that he still used a 6-roll programme in his factory.

Mr. Whitehead considered that, generally speaking, 6-roll programmes were used much less than formerly.

(3). *Intervals of Charging 1st Roll Rollers.*—Mr. Whitehead stated that a shorter charging interval would give short range fermentations, as well as long range, whereas a longer charging interval

had definite limits as regards short range fermentations. He instanced two cases where the following fermenting scales were in use:—

Charging interval 50 minutes.

Scale A, long range.		Scale B, short range.	
	hrs. mins.		hrs. mins.
Dhool 1 Fermenting time	1 25	Dhool 2 Fermenting time	2 45
,, 2 ,, ,,	1 30	,, 1 ,, ,,	2 55
,, 3 ,, ,,	2 05	,, 3 ,, ,,	3 00
,, 4 ,, ,,	2 45	,, 4 ,, ,,	3 10
,, 5 ,, ,,	3 25	,, 5 ,, ,,	3 25
,, BB ,, ,,	3 35	,, BB ,, ,,	3 35
Range 2 hrs. 10 mins.		Range 50 minutes.	

A charging interval of 100 minutes would of course give a minimum range of 1 hour 40 minutes.

Mr. R. C. Scott asked from what district Scale A fermentations were taken.

Mr. Whitehead replied that Scale A fermentations were used in the Maturata district when flavour was marked.

(4). *Temperatures, Initial and Increasing.*—Mr. Whitehead instanced the fact that under normal conditions when manufacture commenced in the early mornings, low temperatures were experienced necessitating lengthening normal fermentations but as manufacture proceeded temperatures rose and correct fermenting periods declined in duration. To accommodate for the above gradual rise in temperature, roller batch weights should be smaller at the commencement of manufacture and increased as manufacture proceeded and the temperature rose.

This might be illustrated as follows:—

Manufacture assumed to be on the basis of:—

Charging interval	50 minutes.
Batch weight	400 pounds.
Drier capacity	8 pounds wet leaf per minute.

Normal fermenting period for 1st dhool of any batch before fired 2 hours 40 minutes.

Supposing that due to low temperatures at the commencement of manufacture, it was considered normal fermentation should be lengthened by, say, 25 minutes for the 1st leaf batch and that by the time five leaf batches had been fermented the temperature would have risen sufficiently to allow of normal fermentation of the 6th and subsequent batches; in this case the extra 25 minutes' fermentation given to the 1st batch should decrease by 5 minutes for each of the first five batches, and normal time (2 hours 40 minutes) be given to the 6th batch.

Since the drier took 8 lb. leaf per minute and 5 minutes was to be dropped from the first five batches, then the weight of the first five batches should be $5 \times 8 = 40$ lb. less than the standard roller charge of 400 lb., *i.e.*, 360 lb. This would give:—

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Mr. Francillon asked if Scales A, B and C were used at different times of the year.

Mr. Whitehead said this was the case, the scales being accommodated to the incidence of flavour.

(6). *Order of Firing Dhools and Bulk.*—To illustrate how fermenting periods would vary by changing the order of firing of dhools and bulk, Mr. Whitehead gave the following examples of fermenting scales. In each case the earliest fermentation was 2 hours 45 minutes and the latest 3 hours 40 minutes.

D				E				F			
Dhool		hrs.	mins.	Dhool		hrs.	mins.	Dhool		hrs.	mins.
1st	Ferm. time	2	45	2nd	Ferm. time	2	45	3rd	Ferm. time	2	45
2nd	,, ,,	2	50	1st	,, ,,	3	00	1st	,, ,,	2	55
3rd	,, ,,	3	05	3rd	,, ,,	3	05	2nd	,, ,,	3	00
B	,, ,,	3	15	4th	,, ,,	3	15	B	,, ,,	3	15
4th	,, ,,	3	25	B	,, ,,	3	30	4th	,, ,,	3	25
4th	Completed	3	40	B	Completed	3	40	4th	Completed	3	40

(7). *Range of Fermentation.*—Mr. Whitehead went on to say, it could be assumed that the leaf of any given batch became well mixed up during the first roll. This bulking or averaging would have some effect in giving to that batch a certain characteristic as far as fermentation was concerned, and one could expect that the intervals of time between the correct fermenting periods for all dhools and bulk would obey some sort of fairly regular law. The first dhool, because of the small amount of work done on it, might require longer to ferment than, say, dhool 3, but one could argue that the overall interval between the firing of the 1st dhool to be fired and the last would be a fairly constant kind of interval. The only exception would be the presence of flavour in early dhools. But assuming no particularly noticeable flavour to upset the rule, it was, he thought, reasonable to look for some sort of fairly well-defined range or interval of time into which all the leaf would fall. A large number of tests tended to show that in the absence of flavour there was such a range which varied from 50 to 60 minutes, and it therefore followed that rolling programmes might be better if they were made to fall within this range.

DISCUSSION ON MANURING AND CULTIVATION

Mr. Rettie opened the discussion and said: "When Dr. Norris invited me to open the discussion on this subject I readily agreed to do so because it has always appeared to me that informal conferences of this nature where delegates could, so to speak, sit round a table and pool their ideas and experiences would be invaluable. Methods of agricultural practice, like opinions, vary considerably and there is little doubt that the same result is often attained by different means though there must always be a right and a wrong method. Today's Conference may perhaps help to remove some misconception and narrow down differences.

The subject of cultivation is a large one and as our time is limited and others present will wish to give their views I shall deal as briefly as possible with one or two of the major aspects. Naturally our attention at the moment is focussed on the economics of manuring under wartime conditions and we have to find ways and means of evolving rational cultivation programmes. Just at present ample supplies of fertilisers are available, though not in the cheapest form, and rationing of inorganic constituents has become necessary. For a time supplies of nitrate of soda relieved the position, but this fertiliser has now been diverted to manuring of rubber so that still greater dilution with the more expensive organic types is unavoidable until such time as further supplies of inorganics become available. The natural inclination is towards immediate economy in manuring either, as Dr. Eden has put it, by maintaining the dose and increasing the intervals of application, or by reducing the dose and maintaining the intervals. But before rushing to either expedient we would, I think, do well to pause. Many of us will remember the last post-war slump and the debilitating effect on the tea of a stoppage or severe curtailment of manuring and the time and expense involved in rectifying matters. Not only were crop, foliage and wood growth affected but internal decay and disease increased enormously as did shot-hole borer in areas afflicted by this pest. It was, I believe, more the increase in disease and decay than anything else that led to the adoption of pruning mixtures on many estates. I am not, however, going to dilate on that subject now as it has proved to be highly controversial and to generate a certain amount of heat! I think therefore that we should be very careful to avoid making similar mistakes again unless and until our hands are forced through failure of manure supplies, or unduly high costs. We must not lose sight of the fact that most of our tea is twenty-two years older than it was then.

Though the price of substitute mixtures has risen anything up to 45 per cent, estates which have tendered their teas to Government are to receive compensation for enhanced costs due to the war, and for others the level of tea prices is well maintained, though how long this will continue remains to be seen. In any case, I think you will agree that manuring should have priority and a full and reasonable programme be maintained for as long as possible.

As regards actual manure prescriptions, we have little choice under rationing and the principle of applying the simplest and cheapest mixtures obtainable to meet plant food requirements might be followed. In this connection, it would be useful to have Dr. Eden's opinion regarding the continued use of nitrate of soda, the time-limit in which this fertiliser can be stored when mixed with superphosphates and bonemeal and its use in the wetter zones. My experience is that heavy rushes of crop follow its application and, if doses are continued for long the bush tends to lose foliage. In choosing mixtures we must be guided by our technical advisers, and the suggestion by the Institute of a consultative committee to see that all receive fair and equal treatment seems a sound one. I think it will be agreed that economy in manuring should never be at the expense of essential ingredients such as potash and phosphates for both are necessary within limits laid down by the Institute. It may do little harm to reduce them for one year as a temporary measure, though not longer. At least we need not revert to the very complicated mixtures previously in use where the numerous nitrogenous compounds they contained were supposed to become available in strict rotation, a fallacy pointed out some time ago by Dr. Eden.

Then comes the question of doses and intervals of application. I believe the Institute advises graduating the dose as the productivity of the bush increases with a reduction towards the end of the pruning cycle. Crop returns from experiments may support this, but I would urge the point of view that though the response per unit of nitrogen may be less towards the end of the cycle the intrinsic value of the leaf is greater up-country. I have personally had good results at high elevations from steadily increasing doses throughout the cycle provided the last application is not made later than one year to nine months prior to pruning.

As for the relative effect of applying large doses infrequently against small doses frequently, this seems to me a question of local conditions, climate and crop requirements. The response to large, annual doses is perhaps better at the higher elevations where a heavy cover of tea exists, but the normal practice of short periods at mid and low elevations appears to give the better results. Actually,

this may have to be modified and longer intervals adopted where economy is vital. Anyway, the response in crop is in direct relation to the manure applied and it seems doubtful if manure has much direct effect on crop 12 months after application though the bush may have become more vigorous and a wider feeder. Manuring of dry zones, which only enjoy one monsoon, presents difficulties and it is often necessary to subordinate the best agricultural practice to other aspects of estate management such as labour distribution, manufacturing facilities, transport arrangements and so on to ensure economical working. The object, of course, is to secure as even a crop incidence as possible, a much easier matter in the more temperate S.W. districts where cultivation is possible most of the year.

To illustrate my point — Many years ago, when quality was a secondary consideration, it was the custom in N.E. districts, particularly Uva, to prune exclusively during the dry period, from June to August, and to manure the whole acreage from January to April, when root activity was at its highest, undoubtedly the best time for obtaining maximum response from manure. But this led to heavy rushes of crop in the early months, most difficult to handle and manufacture even with day and night shifts in the factory, followed by a decline in crop from June to August when it became difficult to find employment for surplus labour. A more rational policy was gradually evolved by pruning a proportion of the programme in the spring and the balance in the second half of the year, manuring two-thirds of the acreage in the spring and one-third in the autumn which has since been further modified with good effect. The trouble with N.E. districts is that manure applied in the last quarter of the year during the rainy season is generally less effective. At all events the result of a more even distribution of manuring and pruning programmes throughout the year has been entirely satisfactory and much more economical. Two doses of manure, one applied about March-April prior to the drought and a second about September following the drought, has given good results at low elevations in dry zones. Perhaps Dr. Eden will give his opinion, and delegates their experience, of broadcasting inorganic fertilisers during droughts when light showers fall. I have known this to be effective. One need hardly emphasise that a reduction in manuring means a curtailment in pruning periods, a thing to be avoided if possible as the less ageing tea is subjected to the knife, the better. Manuring of tea in N.E. districts must certainly be on a more liberal scale than on the S.W. side, a fact not always appreciated.

As for the treatment of good and poor yielding areas, here also it is surely a matter for individual consideration, and in the latter

case one of economics. One sees many worn-out areas steadily declining where little response is obtained from heavier doses of manure and the solution is either abandonment, except for the coupon value, or replanting, though replanting is not always a paying proposition on impoverished soil. When yield drops below 400 lb. per acre it is well to work out a profit and loss account and see just how far manuring pays. That replanting on a wider scale will have to be adopted in the near future seems certain and it is well to make provision for this in good time. The need for liberal green manuring, both of backward and good areas, requires no emphasis. It is difficult to carry this too far provided the crop and shade are properly controlled. The use of bush legumes is becoming more general, and I suggest the advisability of planting, say, wild sunflower in ordinary field drains as well as in waste spaces, ravines and leading drains where green manure supplies are scanty. I have known over 20 tons per acre per annum additional green manure obtained from this source alone. We can also keep our manure bill within reasonable limits by immobilising and protecting soil by encouraging larger bushes, thatching, establishing ground cover crops, selective weeding and terracing. All these call for special attention at present. What amazes a visitor to Ceylon from other tea-producing countries is the amount of soil exposure on our estates. It made one shudder to see the ground swept clean even immediately prior to the burst of the S.W. monsoon when composting was a popular phase on some estates.

Forking seems to me to merit closer attention and it would be helpful if a special article devoted to this subject were published in *The Tea Quarterly*. Going round, one is struck by the varied interpretations of the system known as "envelope forking" and the amount of damage done. On one estate known to me, where no weeding scrapers have been used for a period of 19 years, deep depressions between the rows of tea, pinnacled bushes and root exposure were in general solely due to inefficient cultivation. Too often is forking done across, not against, the slope of the hill and much soil lost thereby. Fortunately, shallow cultivation is much less practised, but what is known as deep forking is not always such in reality. Drainage too has vastly improved and it is now generally appreciated that efficient drainage is necessary more to assist subsoil aeration and prevent water-logging, especially in S.W. districts, than for the removal of surface water. In manuring of tea the effect of hard plucking and pruning systems are too little taken into account. A close plucking system is forcing and creates more flushing points necessitating heavier manuring, and it is possible to economise by modifying this practice. Above all, it seems to me essential to maintain the full health and vigour of the revenue-producing medium,

the tea bush itself, as long as we can for there may be difficult days ahead."

The discussion that followed centred chiefly round the following points (a) the use of nitrate of soda in relation to soil acidity, the presence of minor elements, and the weather cycle; (b) manuring in relation to root activity; (c) the broadcasting of soluble artificial manures; and (d) the general fertilizer position.

Mr. P. A. Keiller asked Mr. Rettie for further particulars about the loss of leaf from bushes treated with nitrate of soda.

Mr. Rettie replied by describing the experiment from which he had drawn his observations. The experiment included nitrate of soda, cyanamide and sulphate of ammonia plots in duplicate. The loss of leaf was noticeable on the nitrate of soda plots. He could not remember details of the doses used, but the effect was marked in the third year.

Mr. Durbin raised the question of the presence of minor elements in nitrate of soda, a beneficial feature that was stressed in the literature about nitrate of soda. He had not altogether abandoned the idea that phloem necrosis might be the result of a deficiency in some minor chemical element, in which case the use of a fertilizer known to contain a representative collection of minor elements might be of value.

Dr. S. C. Paul referred to minor elements from another point of view. He asked whether the rôle of minor elements in the metabolic activity of the plant was known. He quoted examples from the sphere of medicine to show that although a normal diet provided all the necessary vitamins for maintaining a healthy individual, in certain persons or in cases of disease an increase in the supply of vitamins became necessary. On the basis of this analogy he asked whether in any plant diseases in which minor element treatment was beneficial, it was possible that they increased the vitamin supply directly or indirectly.

Dealing with the question of soluble manures and the weather cycle, Mr. Durbin said he agreed with Mr. Rettie about the difficulty of finding ideal weather for manuring operations in districts subject to N.E. monsoon climate. When the periods were less than a year between successive cultivations the difficulties of fitting in the field operations was complicated. Moreover, manuring just before the monsoon when rain and mist became prevalent was not, in his opinion, ideal. He specially raised the question of the use of nitrate of soda at such times.

Mr. F. R. Francillon said he had some experience of using soluble manure broadcast without forking, and in the Dimbula district he said there was no doubt about the beneficial results obtained.

Mr. S. F. H. Perera, referring to Mr. Rettie's remarks on manuring in relation to root activity, said that as it was customary to time manuring operations according to the incidence of the pruning cycle, the question of considering it in relation to periods of root activity was largely lost sight of, and he thought would merit attention by planters. He asked whether root activity varied in the different parts of the Island.

Mr. Farquharson asked if any information was available regarding the fertilizer position.

Mr. Tonks asked if anything was known of the reason for shortage of nitrate of soda.

Mr. Morford related that in some first year fields the crop had suffered and had responded to manure less readily than late in the cycle. He thought it might be due to drought conditions affecting the bushes after pruning more severely than later on in the cycle. He wished to have an opinion on whether it would be well to manure these fields again immediately after rains set in, or whether the manure not used owing to drought would suffice.

Mr. Ashton stated that as far as his district was concerned bushes in the later stages of the cycle had suffered most.

Dr. Eden in reply, thanked Mr. Rettie for having raised so many points of interest, and said that he found himself in close agreement with most of what Mr. Rettie had said. On the question of reduction in manuring he agreed with Mr. Rettie that it should be undertaken only as a last resort. He thought he had made that clear in his previous pronouncement at the Dimbula Planters' Association shortly after the outbreak of war. As prices of produce and manures were at the time, he thought there was no justification for a reduction which would in his opinion be mistaken policy.

Dealing with nitrate of soda, Dr. Eden stated that the Tea Research Institute had no direct field experimental evidence though a trial had been started, and would take time to mature. Tocklai experience was that using nitrate of soda only, yields began to recede below the level of sulphate of ammonia after some four years. The Indian station distinguished between a deterioration in tilth and in acidity. What would happen on our soils remained to be seen, and this would vary according to the initial condition of the soil with regard to these two characteristics. But he would view with some misgiving permanent manuring with nitrate of soda as the sole source

of nitrogen. Used as was the case up to that time, *i.e.*, balanced against an equal quantity of sulphate of ammonia, there were no reasons to expect a deleterious effect from long and continued use. Dr. Eden explained that, in effect, when using nitrate of soda one left the basic part of the compound in the soil and thus tended to reduce acidity. When using sulphate of ammonia, the basic part was the ammonium radicle. This part was the nitrogen supplier, and after various chemical changes was removed either by the plant or by drainage leaving the acidic part behind. A mixture of the two manures, sulphate of ammonia and nitrate of soda, or the alternate use of them in equivalent proportions would maintain the acidity at a value favourable to tea. As regards storage of mixtures containing nitrate of soda, there would be no difficulty if a conditioner were used. A recent experiment on storage with mixed manures had shown how efficient in preventing caking and deliquescence were conditioners like castor meal.

Turning to minor elements, Dr. Eden said a correct perspective was needed. We were not habitually manuring with synthetic products alone. He referred to a comprehensive series of analyses of mixed artificial fertilizers made in America which showed determinable quantities of all the frequently quoted minor elements, copper, manganese, zinc, boron, etc. On certain geological formations these deficiencies of minor elements made themselves acutely felt He knew of no work linking minor element deficiency with a corresponding vitamin deficiency. He thought, however, that unless definite evidence was forthcoming the practice of continually adding minor elements was rather like a person who lived on a mixed diet continually taking codliver oil at every meal for fear of a vitamin deficiency.

Dr. Gadd added information regarding minor elements and pathological conditions. The knowledge of the minor elements required by plants had been derived largely from pathological investigations. It had been found that plants exhibiting various symptoms could be cured by supplying them with certain elements in minute quantities. For instance, a disease of tea in Nyasaland known as 'Yellows' could be cured when the diseased bushes were supplied with sulphur. It had long been known that sulphur was required by plants, but normally it occurred in sufficient quantity in soil, and its addition in manure mixtures was not considered necessary. Other plant diseases had been proved to result from deficiencies of other elements, such as boron, whose functions within the plant were not understood. All that could be said was that certain diseases could be caused by depriving the plant of definite elements and they could be cured by supplying them. What happened to those elements

after the plant had absorbed them was not known. Evidence was accumulating to show that the minor elements were as essential to plant life as vitamins were for animals, but whether the minor elements were first built up into anything resembling vitamins was unknown.

Dr. Eden continued by referring to Mr. Rettie's enquiry about how long the effect of fertilizers lasted. The results of an examination of the nine years' records of the general manuring experiment had shown that the effect of manure began to be felt between the second and third month after application at St. Coombs. If the difference in yield between plots receiving greater and lesser amounts of nitrogen or between manured and unmanured plots was followed, there was a definitely distinguishable rise in the percentage gain at about this time. Dry weather always minimised that response and sometimes completely wiped it out. But later when rain was again prevalent the response recurred. It was of interest to find that, calculated as a response, the figure attained a maximum during the S.W. monsoon even though total cropping capacity was not then at its maximum. A further point was that when manuring was carried out in the N.E. monsoon period, there was still a very pronounced response during the succeeding S.W. monsoon, nine months later. Rain seemed to be a prime necessity for response. Without dogmatising unduly, the indications were that this phenomenon was associated with the probability that the tea plant took up the bulk of the nitrogen supplied within a very short time of application and stored it, making use of it as the environmental conditions demanded. Mr. Rettie had referred to the use of incremental doses through the period of the pruning cycle. Some evidence on this score was available from the same set of data. Again, calculated as proportional gains, the values increased from the first year onwards. The use of smaller doses at the end of the cycle which had been recommended by the Institute was confined to special cases in which the time of application left only a diminished period during which the nitrogen could be effectively used, because of the intervention of pruning. The manuring cycle in conditions of a single monsoon climate were difficult and he was not yet in a position to lay down a general procedure. But experiments at Passara and Balangoda had shown that nitrogen response was less effective under these conditions than in the regions of two monsoons and undoubtedly the dry weather was a contributory cause.

Mr. Morford's problem regarding manurial response and drought was in keeping with what he (Dr. Eden) had said in describing his experimental results. He did not think further manuring

would be economic. The observation that first year fields had suffered most was not parallel to his own observations but it was possible that the bare soil had lost much moisture by direct evaporation, and so soon after pruning the extent of the root system would be less than later on. That might explain Mr. Morford's observation.

With regard to manuring and root activity, a survey of root activity during the pruning cycle had been started, but owing to the necessity of amalgamating the divisions of Agricultural Chemistry and Plant Physiology owing to Dr. Tubbs' absence on war service, it had not been found possible to proceed with that survey. There was no doubt however that after drought, some time must elapse before an active feeding root system was regenerated. Such periods of drought were in his opinion harder on the root system than envelope-forking which, as the cultivation trials reported at the last Conference showed, did relatively little damage to the roots. He did not think excessive forking needed any encouragement and soluble nitrogenous manures were probably used efficiently when merely broadcast. Potash and phosphate were liable to be concentrated on the top layers when forking was omitted. Insoluble manures, if not anchored by forking, were liable to loss if run-off developed as a result of heavy plumps of rain.

In reply to a question interposed by Mr. Rettie, regarding the effect of nitrate of soda on the liberation of soil potash, Dr. Eden said that the basis of that argument was the permanent mangold experiment at Rothamsted. On a crop so sensitive to potash as mangolds, some benefit undoubtedly arose from the use of nitrate of soda or salt. Tea on the other hand showed no such delicacy and the potash supplied as manure was in the nature of replacement of that removed by the crop. The use of nitrate of soda would not conserve the potash supplies.

Mr. Keiller then dealt with the general fertilizer position. Summarizing, the circumstances were such that sulphate of ammonia was almost impossible to obtain, nitrate of soda was procurable at an enhanced price, but organic fertilizers such as groundnut cake were easily obtainable from India. Phosphates and potash supplies were determined mainly by freight and were not subject to the voluntary rationing.

Mr. Keiller went on to say that within the limitations mentioned by Dr. Eden the use of nitrate of soda was entirely suitable. It would be wrong to suppose that nitrate of soda was a manure that should not be used. He could not explain Mr. Rettie's

results. He had reports of the use of nitrate of soda over long periods without any detrimental effects. On rubber he had applied it for 25 years as the sole source of nitrogen without harmful effects. If he remembered correctly, the Indian experiments only began to show effects after increasing the dose. Obviously the amount used and the soil type were of first importance. On the rubber plot previously mentioned, girth measurements showed the most favourable increase when using nitrate of soda, because of its rapid action. It was also remarkable that the increase varied directly with rainfall. This seemed to indicate that fears of loss in wet weather were exaggerated. Mr. Tonks had raised the question of nitrate of soda supplies. The fertilizer firms were carrying enhanced stocks and had laid out a large amount of money on those then held. But they had to bear in mind that if sulphate of ammonia were released, it would be preferred by the buyers, so that it was not practicable to order nitrate of soda continuously without considering the developments in the sulphate of ammonia situation. As the latter position was not then completely clear, there was at that moment a temporary shortage of nitrate of soda for which there had been a large demand.

Dr. Norris outlined the scope of the consultative committee set up in conjunction with the other Research Institutes and the fertilizer firms for discussion of stocks, present and in sight, and for the recommendation of rationing. The Institutes were very fully informed as to prevailing conditions and they would be ready to advise estates at any time on the most advantageous manurial policy.

DISCUSSION ON PESTS AND DISEASES

(A). SHOT-HOLE BORER

Mr. Grant Cook began the discussion by saying that he had been asked to open the subject, probably because his property was one of the first to appreciate the serious damage caused by Shot-hole Borer and because experiments on this pest had been carried out on the estate for a protracted period by officers of the Department of Agriculture, particularly Mr. F. P. Jepson, who spent fourteen months there. Mr. Jepson's conclusions were that adequate cultivation could to some extent overcome loss of crop due to the borer, but that the real answer was to find a natural enemy. Since 1924, when Mr. Jepson finished his experiments, the pest had increased so much that it was difficult to find a branch in any of the tea, unaffected.

A further serious aspect was the development in the past few years of branch rot, first noticed in young fields at their centering at about eighteen months from planting. On pruning and splitting a branch, a yellowish-bluish stain was noticeable, and the branch was found to be riddled with shot-hole borer. Subsequent prunings showed that definite rot had set in which later completely hollowed out the branches. His contention was that both stain and rot were due to shot-hole borer, resulting from the ambrosia fungus or excreta; evidence of this was that where there was no shot-hole borer, there was no stain.

His opinion was that shot-hole borer was responsible not only for loss of crop but for death of the bushes and was quite definitely affecting the capital value of the estate. Immediate steps should be taken to find a parasite for experiments connected with artificial control were, in his view, a waste of time and money. The species of *Xyleborus* which attacked coffee in Java was, he understood, considered to be effectively controlled by a parasite; the fact that the species which attacked tea so severely in Ceylon was of so little importance in Java suggested an efficient controlling agency. It would be advantageous to discover the explanation for this difference in status in the two countries, and an officer should be sent by the Tea Research Institute of Ceylon to enquire into this. Such a request would have the strong support of everyone in Uva.

Mr. R. G. Coombe associated himself with all that Mr. Grant Cook had said. He was struck with the enormous amount of damage done by shot-hole borer not only in Uva but also in other areas such as Ratnapura and Balangoda. The position in Uva was that large numbers of bushes were completely disappearing. The Institute should try and get a parasite to do what had been done so effectively for Tortrix, and, if possible, arrange for Mr. Redman King to go to Java to find something.

Mr. Coombe said that a short time before, during a discussion with a member of the Institute staff, he had been surprised at being told that shot-hole borer was not a serious pest of tea. In fact that officer had gone so far as to state that if a list of the worst pests of tea were prepared, shot-hole borer would not be amongst the first six. He regarded shot-hole borer as a very serious matter and urged the Tea Research Institute to take up the subject again and endeavour to give some relief to the affected districts.

The Director then suggested that Mr. Redman King should deal with the question of biological control.

Mr. Redman King first referred to the great increase in work on biological control which had taken place in the last twenty years or so, America taking a foremost part. But the number of successes was a very small fraction of the number of attempts made. Success depended on many factors, but had been chiefly attained in small geographical areas and against introduced pests, such as occurred in Hawaii on sugar cane, where much of the early work was done. The particular case of Tortrix was only slightly different, in that it was not an introduced pest, but it happened that its parasite fauna in Java was not altogether the same as in Ceylon.

The chances of doing the same for Shot-hole borer as for Tortrix was very much less because its mode of existence was entirely different, the pest passing nearly the whole of its life enclosed in a branch, and so offering very much less opportunity for parasitism than in the case of the Tortrix caterpillar.

The whole genus *Xyleborus* contained well over a hundred different species, and only a few were known to have parasites. Consideration of the search for a parasite must take into account the relationship to their general surroundings, including their host plants which were often severely limited; a memo on that subject had already been circulated.

The question of parasites had been discussed at Farnham Royal by Mr. Austin and himself, and doubt was expressed at any beneficial outcome of parasites they were able to collect. The opinion of

Mr. Beeson, Forest Entomologist at Dehra Dun, and a specialist on *Xyleborus*, was quoted: "……*Xyleborus* seems to be entirely free from wood parasites of hymenopterous families …… I very much doubt that you will find a parasite or predator that can be used to control *fornicatus* in tea bushes……I think you are following an unproductive line of research in supposing that the parasites and predators of Scolytidae of pines in England will be of use for *fornicatus* . . ."

The Director then referred to his visit to Java with Mr. Forbes in 1935 and said that they had discussed the control of pests there, but that no work had been done on shot-hole borer as it gave no trouble. Just as climatic conditions limited *Helopeltis* (which was the worst pest of tea in Java) in Ceylon, so they might also limit shot-hole borer in Java. There was no evidence to show that a parasite was at work. Further information on this point had been solicited. The Institute had also been trying to get in touch with America on the subject of predatory mites. It was clear that shot-hole borer was very differently regarded in different areas and he referred to the Annual Report of the Planters' Association of Ceylon for 1939 where it was stated that in the low-country this pest would not appear to be an economic factor under present standards of cultivation. Much of the tea in the low-country, however, was comparatively young and had been heavily manured from the start.

With regard to the references to shot-hole borer on coffee in Java, Dr. Norris explained that this was a different species of *Xyleborus*.

Dr. Gadd said that Mr. Grant Cook had referred to the work carried out by Mr. F. P. Jepson of the Department of Agriculture, with which work both Mr. Grant Cook and he had been associated. The conclusions drawn from those investigations were that manuring did not reduce the number of beetles though it did materially assist in reducing the damage resulting from their attacks. The gallery entrances healed more rapidly, and growth was speeded up, thereby reducing the risk of breakage of the branches. It would generally be accepted that cultivation and manuring did not do anything towards eradicating the beetle though it did much towards repairing the damage done.

Mr. Grant Cook had also referred to the discoloration of the wood around shot-hole borer galleries. There were numerous shot-hole borer beetles which attacked trees and damaged the timber. The attacked timber when sawn showed the holes made by the beetles, and around the hole the wood was usually stained. Wood staining was usually associated with borer attacks, and that staining

plus the holes diminished the value of the timber. But he had not come across any suggestion that such timber was also weakened by rot.

The wood around shot-hole borer galleries in tea branches was also stained as described by Mr. Grant Cook. The colour of the stained wood varied somewhat. The question was whether the discoloration was the beginning of wood rot. To that question it should be possible to give a direct answer, yes or no. He had attempted to answer the question by isolating the fungi from the stained wood, and then transferring them to blocks of wood to ascertain whether they caused the wood to decay. In no instance had he isolated from around a shot-hole borer gallery a fungus which later caused a decay of wood. He had also bored holes into growing tea stumps and inserted fungi isolated from around shot-hole borer galleries. When later the stumps were split no evidence of decay was found. From these experiments he felt justified in concluding that the staining of the wood around the galleries was not the beginning of wood rot.

When the beetle had bored its gallery, it planted on the walls a specific fungus known as an ambrosia fungus. As the fungus grew the beetle larvae fed upon it. That fungus culture was surprisingly pure though occasionally a few other fungi might be found contaminating it. When isolating the fungi from the wood around galleries the one which was most commonly obtained was of course the ambrosia fungus, but that fungus did not cause wood rot in any experiment carried out with it. Most of the isolations were made from branches supplied by Mr. Grant Cook.

The beginning of wood rot was usually seen as a discoloration of the wood, and one was apt to jump to the conclusion that decay had started whenever a discoloration of wood was observed. The fungi which caused wood rot had a very definite function to play in nature, and any exposed wood unprotected by living tissue was liable to attack and decay, no matter whether it was sawn timber or the exposed wood of a pruning cut or broken branch. Shot-hole borer attacked branches were liable to breakage and the exposed wood was then liable to attacks by wood rotting fungi. Whether such branches were more liable to decay than normal pruning cuts he did not know, but he felt certain that the fungi which stained the wood around the galleries were not those which caused the decay.

Dr. Gadd said that he was the officer referred to by Mr. R. G. Coombe as having expressed the opinion that shot-hole borer was not so serious a pest as some people would have them believe. That opinion was his personal opinion and did not in any way reflect the

policy of the Institute nor, so far as he knew, the views of Mr. King who was responsible for the shot-hole borer investigations.

He then proceeded to give some of the reasons why he had formed that opinion. He said that he had seen yield figures of an estate dating back for many years. On that estate shot-hole borer was said to be on the increase. The yields had also increased, which did not indicate that the pest had had a very depressing effect on the crop. In fact he had yet to see any estate records which clearly indicated that shot-hole borer did have a marked effect on yield.

From a botanical point of view the damage caused by the beetle was not of a serious nature. The insects bored holes into the wood, but if those holes interfered with the flow of water to the leaves, the leaves would wilt. That however did not happen. It might also be argued that although the beetles fed on the ambrosia fungus, the fungus extracted for its own requirements food material from the stem, which might otherwise be harvested as crop. That of course was true, but the amount of food material involved could not be very great, judging from the way in which heavily infected bushes grew.

When entering a branch the beetle often made the entrance to the gallery just below a bud and as a consequence such buds often failed to grow. That resulted in a certain amount of dieback after pruning. Also the presence of a gallery weakened a branch so that there was a tendency for it to break at that point. Those were the two most important forms of injury caused by the beetles as they tended to reduce the frame. A marked reduction of the frame would however affect the crop.

Viewed in that way the importance of the pest seemed to him to have been exaggerated in some quarters. But that did not mean that further investigations should not be carried out. He thought that further work might result in a better understanding of the pest and supply better methods of control.

Mr. Redman King treated it from a broader standpoint, and said that if bark beetle and borer injuries in trees generally were commonly followed by wood rot, there should be plenty of information available from the forester and the forest entomologist. However, it was quite otherwise, and in text books on forestry and forest entomology, although much space was devoted to the consideration of wood rot and of boring insects, there was nowhere a suggestion that the latter was in any way connected with the former.

Mr Grant Cook stressed the increase in shot-hole borer and the gradual deterioration in the capital value of the tea.

Mr. R. G. Coombe said that the frames of the bushes were damaged to such an extent that there was nothing left of them.

Mr. Redman King then asked how this damage could be assessed, and suggested that the only satisfactory answer would be in terms of crop. The damage done by breakage should show a decrease, or over a period of years a progressive decrease. The average yields from the worst field on an estate badly infested by shot-hole borer were then shown in the form of a graph, demonstrating a gradual rise of yield from 700 lb. per acre in 1920 to 940 lb. per acre in 1927, then a gradual drop to 615 lb. per acre in 1935, followed by a rise to 780 in 1938. He expressed the opinion that this did not look very serious, and that the damage inflicted was very much over-rated. The problem of yield in relation to damage was at present under investigation.

Mr. Rettie stated that his experience was that shot-hole borer in many cases was infinitely worse in Uva 30 years ago than today. At the same time he thought it very serious, especially in the dry districts, and only kept at bay by intensive cultivation.

Mr. S. F. H. Perera said that in spite of heavy cultivation the pest still persisted and that it was not due to the dryness of the weather. Mr. Hall and Mr. Ashton both expressed the view that the pest was increasing in the Kotmale area, and

Mr. Morford said that, although an increase in range had been noticed in the last six or seven years in Dimbula, there appeared to be a general decrease in intensity which he thought might be due to the longer pruning cycles and better cleaning up of the bushes.

Mr. Craig referred to the end of the last war when there was little cultivation and shot-hole borer made its presence felt; but for the last 15 or 16 years there had been much less evidence of it in the low-country and little breakage occurred, except perhaps for a short period during the dry weather.

Mr. Keiller observed that anxiety about decreased yields was not shared by everyone, but he had reason to believe that the damage by the borer was only being met and overcome by continued manuring.

Mr. Morford brought up the question of shot-hole borer in rested tea, and said that in small-holdings in Kotmale he was surprised by the marked absence of the borer.

Mr. Hamilton said that he had allowed 100 acres to grow up and found shot-hole borer confined almost entirely to the top of the bushes.

Mr. Farquharson, referring to the Kalutara district, agreed that when fields were allowed to grow up as a form of restriction shot-hole borer only appeared in the top branches.

Mr. Grant Cook differed from this and said that in his tea the shot-hole borer always worked from top to bottom.

With regard to alternative host plants, Mr. Rettie enquired whether something could not be done with Castor oil as a trap crop. Others referred to its presence on Boga medeloa and Coffee.

Mr. Redman King said that much experimental work had been done in the last few years to find out in what other plants shot-hole borer could breed. Of 19 plants tested, only *Mimosa bracaatinga* was found suitable in this way. Castor definitely was not an alternative host plant.

In response to a request by Mr. Rettie, Mr. Redman King then outlined the experiments being carried out on shot-hole borer at Passara. These included:—

1. Studies on life-history and habits, including a continued watch for anything in the nature of natural enemies.

2. Influence of hard and light plucking on population density.

3. Relation of changes in environment to population.

4. Observations on healing in shot-hole borer galleries.

5. Observations on strains necessary to break branches damaged by shot-hole borer.

6. Observations on gallery systems.

7. Alternative host plants.

8. The possibilities of using a spray.

9. Thickness of stems in relation to damage.

The Director in closing the discussion, said that all the points raised would receive careful consideration.

(B). DISEASES

(I). PHLOEM NECROSIS

THE DIRECTOR said the Institute had recruited an additional Research Officer to work in the Mycological Division, mainly on *Phloem necrosis*. Dr. Bond, who had been selected for this appointment, had arrived in Ceylon early in February and was now at work. He would, however, not be able at such an early date to make any report on the subject.

An application had been made for a grant from the Colonial Development Fund to cover part of the cost of this new appointment.

A full account of the data so far available concerning *Phloem necrosis* had been published in *The Tea Quarterly* (1939, Vol. XII, pp. 110-130). He would now invite delegates to put questions in regard to any further information they might desire.

MR. DURBIN said he wished to express the appreciation and thanks of his district to the Institute for the steps taken to recruit a special officer to deal with this disease. At the last Conference he had been one of those who had stressed the seriousness of the disease in the Kandapola area. They would be only too glad to welcome Dr. Bond there and to afford him every assistance possible.

MR. FRANCILLON asked for Dr. Gadd's views concerning the replanting of areas badly affected by *Phloem necrosis*.

DR. GADD said that before replying to Mr. Francillon he would like to make a statement concerning *Phloem necrosis* as his views appeared to be misunderstood in some quarters.

Last year he had addressed three District Planters' Associations on the subject of *Phloem necrosis*. Recently he had read with some surprise a report of a speech by the Chairman of the Nuwara Eliya Planters' Association in which was a statement that he (Dr. Gadd) had made the members of that Association "realise in no uncertain language that the tea industry was a dying industry." If that was true he had made them realise something which he personally did not believe to be true. Admittedly he had painted his picture in sombre colours, but that picture was of a particular disease and not of the tea industry. If a medical officer speaking of a particular disease such as cancer or tuberculosis emphasised its insidious nature, its rate of spread, etc., no one would draw the conclusion that the human race was becoming extinct. Similarly, the vitality of the tea industry could not be measured by the incidence of one disease or

of several. There were better means of judging whether an agricultural industry was thriving or not than by an examination of the diseases to which the crop was liable. He denied emphatically the opinion attributed to him that the tea industry was dying.

His work in the Institute was almost entirely concerned with disease but he had no delusions that the tea bushes to be seen in his laboratory were typical of the millions from which the industry derived its dividends. When he addressed planters it was usually about some disease or other he had encountered in the fields or studied in the laboratory. What he had not yet learned to do was to present an account of some destructive disease as though it were an asset to the industry. When he could do that, perhaps he would be freed of the charge of being a scaremonger.

Referring to the question of replanting badly infected necrosis areas, Dr. Gadd said that he was not prepared to make any general recommendation regarding it. He knew of one estate which had replanted a small area, and others which had put out numerous supplies. The progress of those plants was being followed with interest. As yet the young plants were healthy, but the disease had been recognised in one or two of the older supplies about 10 years old, though as yet they were not severely affected.

Much had still to be learned about that disease and every avenue must be explored for that information. For that reason he would welcome the replanting of small blocks as experiments as he thought that much useful information could be obtained from them. He would not recommend any general replanting scheme at present.

Mr. Rettie said that the results from such experiments would not be available for some considerable time. Dr. Gadd agreed.

Mr. Francillon said that in his experience the disease occurred mainly in tea over 50 years old, but before any large area was replanted some further assurance would be required that the young plants put into such an area would not be affected.

Mr. Farquharson enquired how far the disease had gone down the hill already.

Dr. Gadd said that he had recently received a specimen that looked very like *Phloem necrosis* but it was atypical in one or two respects which made him hesitate to diagnose it with certainty as *Phloem necrosis*. The elevation from which that specimen came was 600 feet. That specimen was rather disquieting as it raised the question whether the disease occurred at elevations lower than previously suspected.

(11) EELWORM

Mr. Gourlay said that he had seen some of the areas affected by the eelworm (*Anguillulina pratensis*) and the sight had given him a great shock. On one particular estate a field which 15 years ago yielded 1,000 lb. per acre would not now give more than 200 lb. per acre. His latest information was that infection was definitely spreading and he asked if suggestions could be made for the checking of that spread.

He also asked whether it would be possible to sterilise the soil or starve the eelworm out of the soil by fallowing, and for information concerning alternative hosts of that parasite.

Dr. Gadd said that a good deal of information regarding the incidence of *Anguillulina pratensis* on one estate had been collected as the Directors had provided an assistant mainly for such investigation. On walking round the estate certain infested areas could be recognised owing to the general appearance of the tea and the problem appeared to be one of confining the worms to such areas. Soil investigations were undertaken to ascertain the limits of such infected areas and the results were somewhat depressing. The problem changed to one of finding areas of soil where the eelworm did not occur.

The conclusion which could be drawn from that survey was that the eelworm was far more wide-spread through an infected estate than casual observation of the tea bushes suggested. He feared that similar surveys on other estates would lead to a similar conclusion. The first problem for an estate was to determine what areas had to be protected and then the best method of protecting them.

Concerning soil sterilisation Dr. Gadd said that he was not optimistic that a satisfactory method for tea lands could be devised. He was however carrying out investigations along that line but was not yet ready to make any recommendation.

He had under observation an area of infected tea land which had then lain fallow for 12 months but live *Anguillulina pratensis* could still be found in that soil. He could not offer an opinion how long would elapse before the eelworm disappeared.

Regarding alternative hosts Dr. Gadd said that *Tephrosia vogelii* and some other green manure plants appeared to be attacked readily. *Desmodium gyrans* was the only resistant one he had yet come across, and he hoped to be able to confirm that conclusion shortly.

(III). GUMMOSIS

Mr. F. R. Francillon said that as Dr. Gadd had already referred them to the Annual Report for 1935 (Bulletin No. 13) page 24 where it was suggested that the major cause of gummosis of grevilleas was drought, he had nothing further to ask on the subject.

Mr. M. Park said that he had considerable experience of gummosis of citrus, particularly grape fruit, in the dry zone. The trees suffered badly during dry weather; the stems cracked and gummosis followed. He was not aware whether gummosis of grevilleas in any way resembled gummosis of citrus but he had found that an application of white wash to the stems was very efficacious in reducing the incidence of gummosis of citrus. The analogy was that a dark suit was much hotter than a white one when worn in the sun.

DISCUSSION ON TEA SELECTION AND PROPAGATION

Dr. R. V. Norris introduced the subject by referring to Dr. Tubbs' absence on active service and saying that arrangements had been made to carry on the work of the department. In one particular respect they had had a piece of good fortune. They had discovered when Dr. Bond joined the staff, that Mrs. Bond was a trained research worker in horticulture with experience in vegetative propagation. Mrs. Bond was anxious to continue investigational work on this subject, and they would be happy to place facilities at her disposal.

Dr. Gadd said that there appeared to be, in some quarters, a misapprehension regarding the purpose of vegetative propagation — the growing of tea plants from cuttings. Tea plants which had been propagated vegetatively were not necessarily superior to plants raised from seed; in fact, in some respects they might be inferior. In what then lay the value of vegetative propagation ?

He then indicated the essential difference between a plant raised from seed and one raised from a cutting. A seed corresponded to a fertilised egg, and on germination and growth it resulted in a new individual — a true child of its parents. A chick was neither his mother nor father; he was a new individual with characters somewhat different from either parent. Similarly a seedling was likely to be somewhat different from its parents.

When a planarian worm was cut into two, and the head end generated a new tail and the tail end a new head, they had two individuals where there was originally but one, but neither could be regarded as the child of the other. This was not a case of parent and child, two distinct individuals. It was, as it were, the same individual occurring in two places at the same time.

Plants were able to regenerate lost parts more readily than animals, except perhaps the lowest forms of animal life. It was possible therefore to take from a tree numerous branches which under suitable conditions would develop roots and grow into trees exactly like the original. He used the words 'exactly like' there to mean 'like as identical twins.' If the original tree was a male of pyramidal habit like a Lombardy poplar, the cuttings from it would grow into male trees of pyramidal habit. Lombardy poplars could not be grown from seed because the female tree did not exist. All the existing Lombardy poplars had been grown vegetatively and they were replicas of the original; they were all male and had the pyramidal habit and other *inherent* characters of the original. Whether anyone had cut his initials in the original tree was not known but if that had happened the initials were not replicated on the thousands of trees which had been raised from it. Such vandalism would form an *acquired* character, and would not be reproduced by the cuttings. So when he said that the cuttings would grow into trees exactly like the original, he meant that they would be exactly alike so far as inherent characters were concerned but not as regards acquired characters.

The reproduction of specific characters of a particular plant was more certain when vegetative propagation was adopted than when seed was used, provided that the characters to be reproduced were inherent and not acquired.

The chief tea characters one wished to produce were high yield, good quality and resistance to specific diseases. Were such characters inherent?

From what was known of other crops they might expect high-yielding capacity to be inherent, but they were yet uncertain as to what extent that was true for tea. It was well known that many external conditions affected yield. So, if with great care, a bush which gave a high yield in the field was selected one could not be sure how much of that high yield was due to inherent character and how much to such external factors as its location (it might be growing in a pocket of good soil), early training (such as good pruning in its early stages of growth which led to good spread, maintained by later good pruning) or other accidents. By vegetative

propagation they could raise plants with similar inherent yield characters, but they could not breed the accidents, the acquired characters. So if the high yield of a selected plant was due largely to accident the replication of the bush by vegetative propagation could only lead to disappointment.

The same remarks applied when selection was made for quality or disease resistance. They could not be sure that they had inherent quality or inherent resistance until the selected bush was propagated vegetatively and the resulting plants tested.

Dr. Gadd said that he was particularly interested in selection for disease resistance. When selecting for disease resistance, he was not looking for a type of tea bush that would resist all diseases. He was pretty certain that that type of bush did not exist. The most he could hope for was to find a type, or even one bush, that was resistant to one particular disease. The disease he had in mind was that caused by the eelworm *Anguillulina pratensis*.

Field evidence suggested that some bushes were more resistant to eelworm attack than others. Whether that resistance was more apparent than real had yet to be determined. If that resistance could be proved to be real they would have valuable plant material for infected areas. But that resistance had to be proved. It was common to see in Poria patches two or three healthy bushes surrounded by vacancies from which Poria infected bushes had been dug out. One asked: "Why were those bushes not attacked? Were they resistant to Poria or did they by some freak of nature escape infection?" He said that the answer was that they were lucky escapes and not resistant. The same answer might be true of bushes selected for apparent resistance to *Anguillulina*, though he was optimistic at present that some bushes would prove more resistant to attack than others.

That work could only be carried out on estates which were infested by the eelworm and what had already been done had been rendered possible by the fact that one estate had appointed an assistant to carry on that work under his supervision. He pointed out that the discovery of a resistant type would not be of immediate commercial value unless it also gave fair yield and quality. In that work, their first choice was resistance, then came quantity and quality, but all three characters together were required.

The original choice had to be made in the field no matter what character was being selected and he emphasised strongly the importance of that selection work. He said that the methods of propagation might be perfect but unless the right choice was made in the field, propagation would be of the wrong material.

Selection work should not be lightly undertaken as it was full of disappointments. They could not be certain what had been selected until the material was propagated and tested. That took time, a lot of time, and patience.

Dr. Eden said, that some months previously he had attended a meeting of a Sub-Committee of the Dickoya Planters' Association, composed of members interested in selection. At that time he was merely keeping Dr. Tubbs' plans working, but had since had to assume responsibility for the direction of the selection work. He wanted to stress Dr. Gadd's points as they applied to selection for yield. It was a fallacy to suppose that having got yields of mother bushes of superior productivity the major work of selection was finished. It would be necessary on estates which were seriously interested in selection to raise the progeny of any mother bush by propagation and to multiply these to a number that would enable them to get a good estimate of the average performance of a clone so as to minimise the effect of factors that were not inherent. The technique and precautions to be taken would be very similar to those taken in manuring experiments where in an analogous way one had to distinguish between the effect of manure and fortuitous effects. Later on he would deal with the question of vegetative propagation but in the meantime he would like to hear the views of any present who had tried this type of work.

Mr. Boileau when asked by the Director whether as a member of the Dickoya Sub-Committee he could give any information, replied that owing to war conditions he had no further progress to report.

Mr. W. J. Craig reported that he had been working on the lines suggested by Dr. Tubbs for three years. From a field of 30 acres he had selected 1,200 bushes by eye. All these bushes were surrounded by other bushes and none had any special advantage in position. For a year they had recorded yields of the individual bushes in groups of 8 pluckings and had reduced the number to 350 in the second year, by rejecting the less favourable yielders. They were now working with the residual 50 best bushes. One bush had a yield 37 times as great as that of the poorest eye-selected bush but that one had a death next to it; the next best was 28 times as productive as the poorest.

Dr. Norris asked if anyone could give information about their success or difficulties with the raising and after-care of cuttings.

Mr. Francillon said in his vegetative propagation trials the first lot carried out on a bungalow verandah well protected from the sun were the most successful. He got about 30 per cent that rooted. In two attempts made later in a leaf shed with galvanized iron roof

and jute hessian sides the cuttings had died. He then had about 400 to 500 cuttings growing. He thought the prolonged dry weather was responsible for most of the damage and he would repeat his trials when the weather was more favourable.

Dr. Eden said that it would be some comfort to Mr. Francillon to know that the Institute had not had any greater success. There was an appreciable difference in the way different jâts behaved in the rooting medium. There were losses at the rooting stage, and further losses at the transplanting stage. Transplanting direct into the field even in good weather had been a failure. They were now using baskets for transplanting. If the primary leaf dropped off before the new shoot was sufficiently advanced there was no hope for that cutting. In peat-moss they averaged 40 per cent alive at the end of a variable rooting period but of these 5 per cent had not actually produced roots. After transference to baskets there was a 23 per cent loss of rooted cuttings after a period of 4 to 5 months. Combining the figures the average success of the whole operation was 27 per cent. Owing to the changes made in the supervision in the department, some of the cuttings had undoubtedly been left in peat too long, but unless they could raise the performance to 80 per cent they could not say that the process was successful.

With the help of Mrs. Bond they were starting a comprehensive study of methods of vegetative propagation and were considering different types of cutting, variations in rooting medium, time of transference and artificial stimulation of rooting by growth regulating and other chemical substances, and he thought that considerable improvement could be effected. Dr. Eden concluded by saying that the work of exploration of methods of raising cuttings was a task that could be done as well by an interested gardener as by a scientist, but to give useful information it would be essential to keep a detailed record of numbers of cuttings used, and of the survivors under various treatments at the various subsequent stages.

The Director said that selection work was closely connected with the question of quality and a good deal of work had been carried out both in Ceylon and India to devise methods for the manufacture of leaf from individual selected bushes in order that quality tests might be carried out. Very successful results had been obtained with this work though the methods in use were not at present such as could be applied on estates. It was of great interest to note that wide variations were found in the quality of tea from different bushes, particularly in regard to variations in the fermentation of the leaf. He would now ask Mr. Lamb to describe the methods in use at St. Coombs; it was hoped later that it would be possible to

adapt these so as to make similar tests practicable on estates where selection work was being carried out.

Mr. Lamb said that the method had been worked out some three years ago in anticipation of selection for quality on an experimental scale. Flush from four bushes had been manufactured separately for a period approaching two years and had given consistent results. The method of individual bush manufacture had been standardised so that differences of quality inherent in the different bushes could be recognised by Tea Tasters.

Withering was carried out on small hessian covered frames which were large enough to take the flush from a single bush. These frames were portable and were carried into a part of the withering lofts where the air distribution was most even. A fairly soft wither was taken, the withered leaf containing about 60 per cent moisture.

Subsequent stages required great care in the matter of cleanliness, and surgical or rubber gloves were worn by the operators. These gloves were thoroughly washed and dried after use and kept in a bottle containing pure powdered talc, the whole surface of the rubber being dusted with the powder. With such small quantities of leaf it was surprising how easily taints were picked up.

Rolling, or its equivalent, was effected by means of a Clivemeare roller. The leaf was twice passed through the machine under full pressure and the crushed material then rubbed over an aluminium hand sieve. Coarse material which had resisted the breaking effect of the roller was passed through a mincing machine. The mincing machine should be chromium plated.

This coarse material had to be broken up and kept with the other leaf to preserve the bulk. The proportion of coarse matter to fine leaf was variable in amount and could not be rejected since this would cause a concentration of the relatively finer parts of the flush in some cases and would lead to erroneous conclusions about quality.

Bulked "dhool" from these operations was fermented in small teak boxes with aluminium partitions, the partitions being inserted in convenient slots cut in the sides of the box. The boxes containing the fermenting leaf were placed in a situation where the humidity and temperature of the air were fairly constant.

Fermentation times were standardised and the leaf fired in the experimental drier in small partitioned sections of a tray, the unused parts of which were blanked out. Drying operations took twenty minutes and temperatures were stepped up at intervals from 160°F. to 190°F. by means of adjustments to the steam control.

The weight of made tea was usually little more than sufficient for one Tea Taster's cup and was sent to Mr. Robert Horne in Colombo for opinion. Mr. Lamb paid a tribute to Mr. Horne who had devoted much time to the evaluation of these individual bush teas and whose opinion had proved remarkably consistent.

Mr. Lamb then proceeded to describe some of the types of tea encountered and the difficulties in the programme of future work. All the bushes now manufactured had been selected for yield but the differences in quality were literally astonishing. The range of types extended from leaf which refused to ferment under any conditions, to leaf which fermented extremely quickly and was fully fermented within an hour of rolling. The programme of manufacture would be complicated in the future by the necessity for giving the rapidly fermenting types two different fermentation periods in order to find whether quality deteriorated by the end of the standard fermentation period which was probably too long for the rapid fermenting types.

A recent article in *The Tea Quarterly* outlined most of the results so far obtained and Mr. Lamb referred to the problems raised by two extreme types, one of which gives high quality with poor colour and strength, and the other, poor quality with otherwise remarkably fine liquors and infusions.

The problem from the selection point of view was complicated by possible changes in market requirements in the future. Bushes which were "good all-rounders" with quality, colour, strength and yield above average would probably be the safest types to propagate.

Referring to the possibilities of individual bush manufacture on estates, Mr. Lamb pointed out that it was only the first stage of a series of operations which became more and more difficult from the estate point of view. Once an individual bush had been selected for yield and quality, it would have to be propagated and again proved by manufacture. Propagation on a scale large enough for manufacture on ordinary factory machinery would be a truly formidable task, if at all possible. The Institute had small scale machinery which would facilitate such work at St. Coombs but it was doubtful whether the Institute would be able to assist in proving clones selected by estates.

Before embarking on ambitious programmes of selection work, therefore, it was advisable to look well ahead in order to make quite sure that there was a reasonable chance of the work being carried to a successful conclusion.

Before closing the Conference the DIRECTOR thanked those delegates who had taken part in the discussions. He thought the latter had been of much interest and they would undoubtedly be of great value to the staff.

As the present Sub-Conference had been the first of its kind to be held DR. NORRIS said he would be glad later to receive any criticisms of the procedure adopted or suggestions as to how this could be improved on future occasions.

MR. R. C. SCOTT expressed the opinion that they had had an excellent Conference. As the idea of this type of conference had originally been proposed by the Planters' Association, he was happy to think the meeting had been so interesting and served such a useful purpose. He hoped conferences of this nature would continue to be held and thanked Dr. Norris and the Institute's staff for the trouble taken in arranging the present meeting.

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 14-12-39

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held in the Ceylon Chamber of Commerce Rooms, Colombo, on Thursday, 14th December, 1939, at 2-30 p.m.

Present.—Mr. James Forbes (Chairman), the Deputy-Financial Secretary, Mr. Collins, representing the Financial Secretary, the Chairman Planters' Association of Ceylon (Mr. R. C. Scott), the Chairman Ceylon Estates' Proprietary Association (Mr. C. H. Bois), Messrs. I. L. Cameron, J. C. Kelly, T. B. Panabokke, S. F. H. Perera, R. Gregor, Dr. R. V. Norris (Director and Secretary) and, by invitation, Mr. H. Tonks, Visiting Agent.

(1). The notice calling the meeting was read.

(2). The Minutes of the Meeting of the Board held on the 13th October, 1939 were confirmed.

Arising from the minutes the Chairman informed members that an application for a grant from the Colonial Development Fund for *Phloem necrosis* had been submitted through the Director of Agriculture.

Letters of regret at inability to attend the meeting were received from the Director of Agriculture and Major Oldfield.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

(a) *Board.*—Reported that Mr. R. G. Coombe had resumed his place on the Board on his return from leave *vice* Mr. Gordon Pyper (acting).

Reported that Mr. R. Gregor had been nominated by the Planters' Association of Ceylon to act on the Board *vice* Mr. J. D. Hoare granted leave.

The Chairman thanked Messrs. Pyper and Hoare for their services and welcomed Mr. Gregor. He also announced that there now seemed some doubt as to whether Mr. Hoare was going on leave; information would no doubt be received in due course from the Planters' Association.

(b) *Finance Committee.*—Mr. R. Gregor was appointed to act on this Committee during the absence of Mr. Hoare.

(c) *Estate and Experimental Sub-Committee.*—Reported that Mr. R. G. Coombe had resumed his place on this Committee relieving Mr. Hoare.

Reported that Mr. G. K. Newton had accepted the nomination of the Board to serve on this Committee.

4. FINANCE

(a) The Institute's accounts to 31st October were tabled.

The accounts were accepted on the motion of Mr. Bois, seconded by Mr. Scott.

(b) *Estimates 1940.*—The Chairman said the estimates had been scrutinised by the Finance Sub-Committee which recommended their adoption subject to one or two minor amendments which he would detail. The Estate Estimates had previously been considered by the Estate and Experimental Sub-Committee.

Estate Estimates.—Mr. Cameron proposed and Mr. Panabokke seconded that the Estate Estimates as amended be approved.

The motion was passed unanimously.

Research Estimates.—The Research Estimates were approved without change on the motion of Mr. Perera, seconded by Mr. Kelly.

The Estimates of Receipts and Expenditure for the year was also approved.

5. MINUTES OF THE ESTATE AND EXPERIMENTAL SUB-COMMITTEE AND FOOD PRODUCTION

These two items were considered together.

The Chairman said the nursery experiments sanctioned at the last meeting of the Board were in progress and the proposals now put forward were on a smaller scale than originally contemplated.

Mr. Collins said the Financial Secretary had expressed the hope that a larger area than 5 acres might be opened under food.

The Chairman referred to the view expressed by the Experimental Committee. The success of any such scheme was somewhat problematical and difficulties were anticipated in the disposal of any crop raised. He thought the Institute's chief function should be to obtain information on different crops for the guidance of estates.

Mr. Collins suggested that the matter of opening a larger area should be reconsidered at a later date, possibly in April, when further information would be available.

The Board agreed to do this.

DISEASES AND PESTS

Recorded the decision taken by Circular No. A. 28/39 dated 22nd November to offer the appointment of *Phloem necrosis* research officer to Dr. T. E. T. Bond.

No further information had been received. Dr. Bond had to give one month's notice and it was hoped he would arrive early in the new year. The Ceylon Association had been asked to assist in securing a passage.

7. RESEARCH ON THE CHEMISTRY OF TEA

Reported that Dr. Bradfield who took up his appointment in July had first of all been working in the office of Messrs. Lloyd, Matheson and Garret, Tea Brokers. He was now working in the laboratory of Messrs. J. Lyons & Co. under Dr. Lampitt's supervision and would continue there for the present.

The Director said he hoped to obtain further details from Mr. Harrison, the Chemist of the Tocklai Station, who was arriving at St. Coombs in a few days and had recently seen Dr. Lampitt while on leave in England.

8. SENIOR SCIENTIFIC STAFF

Reported that Mr. Rogers had returned from leave and resumed duties as Superintendent as from the 14th December, relieving Mr. Parker.

9. T.R.I. CONFERENCE COMMITTEE

The Chairman said there would be no full Conference in 1940, but it was suggested the newly-formed Conference Committee should meet in late February or early March, the Meeting being held at St. Coombs. The Board agreed to this proposal, the final arrangements being left to the Chairman and Director.

10. ANY OTHER BUSINESS

(a) *Small-Holdings.*—The Director reported that a very successful competition had been held in the Baddegama area, and he had recently completed the final judging. He had been highly impressed by the work carried out by Mr. Tillekeratne which was very well organised.

(b) The Board gave permission for the signing of the Agreement between St. Coombs, Mattakelle and Waltrim and Kowlahena Estates for the use of the St. Coombs Road by the last-named estate.

(c) Reported that the Index of Tea Research Institute publications would be ready to go to press in the coming week.

(d) The Board recorded a vote of appreciation to the Ceylon Chamber of Commerce for the use of its rooms for the meetings of the Board.

In closing the meeting the Chairman thanked members for the assistance given him and wished them the Compliments of the Season.

The Meeting then terminated with a vote of thanks to the Chair.

ROLAND V. NORRIS,
Secretary.

NOTICES.

The Institute's Laboratories and Offices are situated at St. Coombs, Talawakelle, and all applications and enquiries should be addressed to the Director, Tea Research Institute, St. Coombs, Talawakelle.

Specimens and other consignments sent by rail should be forwarded to Talawakelle Station c/o Messrs. M. Y. Hemachandra & Co., Forwarding Agents. *Carriage should be pre-paid.*

Visitors' Days.—The *second* and *last* Wednesdays in each month have now been set aside as Visitors' Days at St. Coombs Estate and also at the T. R. I. Sub-Station, Gonakelle Estate, Passara, when it is hoped anyone interested will visit the Stations.

Visitors at other times are welcomed, but it is requested that an appointment be made if possible.

RULES FOR THE OCCUPATION OF ST. COOMBS GUEST HOUSE

(1). The Guest House is normally intended for the use of persons visiting the Institute and St. Coombs Estate on business. Children can in no circumstances be accommodated.

(2). Permission to occupy a room for the night must be obtained from the Director in writing and, unless sufficient notice be given, accommodation cannot be guaranteed. Two double rooms are available for the use of visitors accompanied by their wives.

(3). All visitors must sign the Visitors' Book on arrival.

(4). A bedroom may not be occupied for more than one night if required by another visitor. This shall not apply to Members of the Board or of Committees meeting at St. Coombs who shall also be entitled to priority in the allocation of accommodation when on official business.

(5). Complaints or suggestions shall be entered in the book provided for the purpose and not made to the Guest House Staff.

(6). All payments due for services rendered shall be made in *cash* to the steward-in-charge and a receipt obtained from him on the official form. The scale of approved charges is posted in the building. The steward is forbidden to give credit or to accept cheques.

(7). Liquor is supplied for consumption *in the premises only*.

(8). The Institute accepts no responsibility for cash, jewellery or other valuables of any kind left in the Guest House.

(9). All breakages will be charged for at cost price.

ROLAND V. NORRIS,
Director.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL.

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. G. Coombe

(2) Mr. Jas. Forbes (Chairman).

(3) Mr. J. D. Hoare (on leave) Mr. R. Gregor (acting)

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Major J. W. Oldfield, C.M.G., O.B.E., M.C.

(5) Mr. I. L. Cameron (on leave) Mr. W. H. Gourlay (acting).

(6) Mr. J. C. Kelly

(C) Representing the Low-Country Products' Association :—

(7) Mr. S. F. H. Perera

(D) Representing the Small-Holders :—

(8) Mr. T. B. Panabokke

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary

(10) The Director of Agriculture

(11) The Chairman, Planters' Association of Ceylon

(12) The Chairman, Ceylon Estates Proprietary Association

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

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The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with *the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.*

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.